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Dodecyl sulfate chain anchored bio-char to sequester triaryl methane dyes: equilibrium, kinetics, and adsorption mechanism

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ABSTRACT

A clean and green approach converting waste camel bones to bone bio-char (BC), and its applicability to abate triarylmethane dyes, namely malachite green (MG) and crystal violet (CV), from the aqueous phase was reported. Dodecyl sulfate chain of sodium dodecyl sulfate was anchored over BC (modified camel bone char [MCBC]) surface to enhance its dye sequestering capacity. Adsorption and residual decoloration mechanisms were discussed. Comparatively faster adsorption kinetics for MG than CV was observed. Breakthrough studies revealed profound effect of solution matrix on dyes adsorption. Temkin and Freundlich isotherm models showed better fit for MG and CV adsorption on MCBC, respectively. Thermodynamics study showed spontaneous and endothermic process. The presence of sulfur in elemental analysis and an SO_4^{2-} group peak at 629 cm^{-1} in Fourier transform infrared spectrum confirmed successful MCBC modification. Both MG and CV possess $-N(CH_3)_2^+$ ions and sp^2-hybridized C atoms in their structure. These atoms have a tendency to bind with the –OH group of MCBC through electrostatic interaction/nucleophilic substitution reaction, thus, leading to dyes adsorption. π-electron delocalization results in carbinol derivative formation for both dyes and might be a possible reason for residual dye decoloration with time. Maximum dyes (MG – 45.48% and CV – 44.47%) elutions were observed with acetone and CH_3OH, respectively.

Keywords: Camel bone bio-char; Malachite green; Crystal violet; Sodium dodecyl sulfate; Adsorption mechanism

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